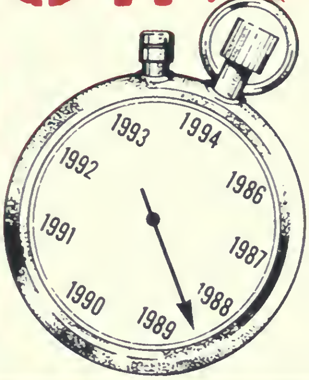
COUNTDOWN ACID RAIN



AFTER TWO YEARS:

Summary and Analysis of the Fourth Progress Reports by Ontario's Four Major Sources of Sulphur Dioxide

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Environment
Ontario

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Minister

COUNTDOWN ACID RAIN

SUMMARY AND ANALYSIS
OF THE FOURTH REPORTS (JANUARY 31, 1988)
DETAILING THE SECOND YEAR
OF EMISSIONS REDUCTION TECHNOLOGY DEVELOPMENT
BY ONTARIO'S FOUR MAJOR EMITTERS OF SULPHUR DIOXIDE

THE ABATEMENT PLAN

Ontario's Countdown Acid Rain program, announced in December 1985, reduces province-wide emissions limits of sulphur dioxide (SO_2) to 885 kilotonnes (thousand metric tonnes) by 1994, from the 1980 base case level of 2,194 kilotonnes. It accomplishes this by means of non-appealable regulations for the four corporate sources which produce about 80% of Ontario's SO_2 emissions. The regulations specify emission reductions starting in 1986 and being fully implemented by 1994. The regulations require the companies to file progress reports on their technology developments each six months, leading up to the final report by the end of 1988 (end of January 1989 for Ontario Hydro) which will show precisely which abatement methods and technologies have been chosen and will detail the financial implications. A complete description of Ontario's acid gas control program can be found in the Countdown Acid Rain information kit available through the Ontario Ministry of the Environment (416-323-4321).

Ontario's four major SO_2 sources are Inco Ltd. and Falconbridge Ltd. (nickel/copper smelters in Sudbury), Algoma Steel Corporation Ltd. (iron sintering plant in Wawa), and Ontario Hydro (all its fossil-fuelled electric generating plants across the province).

For 1987, the second full year the Countdown Acid Rain regulations were in full effect, SO_2 emissions of each polluter (shown in Table 1) were below the legal limit permitted by the four industry-specific regulations.

TABLE 1: 1987 SO_2 Emissions for Ontario's Major Emitters

	1987 Legal Limit (kt)	1987 Actual Emissions (kt)	Percentage of Annual Limit (%)
Algoma (Wawa)	180	85	47
Falconbridge	154	72	48
Hydro	370	332	90
Inco	685	658	96
TOTALS	1,389	1,147	83

As of January 1988 each of the four major SO_2 sources has submitted four progress reports showing its plans to meet the required future reductions. Copies of all the reports and the three previous summary and response reports are available from the Ministry of the Environment.

THE COMPANIES' REPORTS

All companies report they are confident they will stay below the stringent new emissions limits. Technical progress continues to be made, with both Sudbury companies reporting nickel and copper smelting advances. Detailed financial information is not yet available for most of the needed technical changes, because much of the development is not complete and the companies' final decisions await the results of commercial-scale testing. The final reports, due in 1988 when the technology development period ends, must contain technical and financial details showing how the emission reductions will be accomplished. The companies are also required to submit semi-annual reports on the progress being made in implementing the emission reduction plans to be outlined in the final 1988 report.

SUDBURY ORE

All of the sulphur captured or emitted from the Inco and Falconbridge smelters comes from the ore being processed to yield its nickel, copper and precious metals. Ores in the Sudbury Basin typically contain 73% by weight of rock, 20% by weight of the iron sulphide pyrrhotite and 7% of nickel and copper sulphides.

In the milling process, 98% of the rock is ejected as tailings. This results in removal of 5% of the ore's sulphur and 5% of its nickel. After tailings rejection, 25% of the remaining sulphur is combined in the copper and nickel minerals, and the rest in the pyrrhotite.

About three-quarters of the pyrrhotite is magnetic and is separated for rejection utilizing magnetic separators and flotation tanks . The other quarter of the pyrrhotite is non-magnetic and can be rejected by flotation.

Test results have shown that for Sudbury ores, total tailings and pyrrhotite rejection resulting in a removal of two-thirds of the ore's sulphur can be achieved while rejecting only material with a nickel content of less than 2%. This 67% sulphur removal prior to smelting is the level which the mining companies regard as the maximum which is economical.

INCO

In Sudbury, Inco operates a nickel/copper smelter with associated mining and milling operations, and manufactures sulphuric acid and liquid SO_2 from the sulphur in the ores. At 658,000 tonnes a year, Inco is one of the largest emitters of SO_2 in the world.

SO_2 emissions at Inco are very large, not only because of the very large scale of the operations, but also because of the high sulphur content in the ore due to the presence of pyrrhotite. The sulphur input to the smelter, which directly influences the amount of SO_2 generated in the smelter, is determined by the amount of pyrrhotite that can be segregated and rejected during the milling operations. Inco currently mines 11 million tonnes of ore per year containing 1.1 million tonnes of sulphur. If none of the sulphur was rejected or fixed and it was all oxidized to SO_2, acid rain-causing emissions would be 2.2 million tonnes.

Countdown Acid Rain requires Inco to:

- limit its SO_2 emissions to 685 kt effective 1986,
- examine the possibility of reaching a limit of 525 kt by 1990
- reduce its emissions to 265 kt by 1994, and
- examine the possibility of reaching a limit of 175 kt at an unspecified date.

INCO'S JANUARY 31, 1988 PROGRESS REPORT

SUMMARY

Research and testing completed during the second half of 1987 demonstrated that the 265 kilotonne limit for SO_2 can be achieved by a combination of additional pyrrhotite rejection together with oxygen flash smelting of bulk copper/nickel concentrates.

Inco has concentrated on economically attractive technologies without sacrificing metal recoveries and/or precious metal losses. The reductions to be achieved (listed below) were based on an annual nickel production level of 240 million pounds.

How	Amount
A. Increased pyrrhotite rejection	100kt
B. Fixation of SO_2 from flash furnaces	370kt
C. Fixation from copper sulphide (MK) smelting	40kt
D. Fixation from matte processing	30kt

To further reduce SO_2 emissions (265 to 175 kt) a portion of the nickel-copper converter gases need to be captured and SO_2 fixed. Inco reports that at present there is no known cost effective technology to achieve this with nickel/copper ores. Inco also reported that some reductions will occur as new equipment is installed before 1994.

Inco's expenditures on SO_2 abatement and associated research and development for 1987 amounted to $15.3 million.

ONTARIO GOVERNMENT RESPONSE

Inco's report met the reporting requirements of O. Reg. 660/85. The report is a comprehensive document and addresses most of the suggestions made in the third progress review report and the MOE letter of June 5, 1987.

A. Pyrrhotite Rejection

The SO_2/air circuit has performed well. A prototype high efficiency magnetic separator operated successfully. The new bank of Outokumpu flotation cells (13 times larger than the previous units) rejected more sulphur with less mineral loss. An increase in ore grinding capacity may be achieved through improved grinding equipment.

These technological advances coupled with Inco's plan to consolidate milling operations apparently will reject 67% of the sulphur present in the raw ore before the ore enters the smelter, while promoting efficient use of planned new process equipment and reduced operating costs.

B. Bulk Smelting

Flash smelting of the bulk concentrate demonstrated that oxygen flash smelting furnaces would liberate high strength SO_2 gas suitable for sulphuric acid production. However a number of metallurgical problems remain to be solved.

The company appears to be targeting to recover only part of the SO_2 from the matte processing roasters in order to just meet the 265 kt emission limit rather than capturing all emissions possible. The next report should clarify whether additional recovery is feasible.

The decision to proceed with the Sulphur Products Plant upgrade and SO_2 pipeline might preclude the utilization of the variable strength converter off-gases in place of atmospheric dilution in the manufacture of acid.

Inco should re-evaluate this option before it locks into the acid gas pipeline.

C. Upgrading the Existing Acid Plant

References in the text indicate that Inco has decided it will utilize the acid plant at the Sulphur Products Plant (formerly the Iron Ore Recovery Plant) to capture and convert the SO_2 from bulk smelting into sulphuric acid. This will require the upgrading of the existing plants, conversion to a double contact configuration, construction of a new 5 km pipeline from the smelter to the acid plant site and gas cleaning facilities at the smelter. Due to increased SO_2 capture, annual acid production will increase by 120 kt to 550 kt per year.

The progress report lists these research tasks as being currently underway.

A. For Pyrrhotite Rejection

- Modify concentrate thickeners to control a froth build-up.
- Resolve unsatisfactory rock rejection and platinum recovery performance of pyrrhotite rejection circuit.
- Evaluate SO_2/air technology under winter conditions.
- New methods and technologies to minimize metal losses at the higher pyrrhotite rejection rates are being tested.

B. In the Smelter

- Resolution of the problem of contamination of the flash furnace off-gases with high levels of hydrogen sulphide.
- Development of technologies for adding reductants and fuel to the converters to overcome increased high melting point oxide "mush" in the matte.
- Control of the excessive dust generated in the MK flash converting vessel.
- Control of the formation of solid nickel oxide in the MK converting process.
- Improvements in equipment and procedures or modifications of technolgy to address the solid copper-nickel oxide mush buildup during blowing of the semi blister copper.

In designing the pipeline and acid plant upgrade, consideration must be given to public safety and the ability of the company reliably to meet the 265 kt limit in case of shut-downs for maintenance or other reasons.

While a number of problems remain to be resolved in all areas, and Research and Development and pilot work will continue well past 1988, conceptual and definitive engineering studies now underway will produce capital and operating cost estimates by end of 1988.

FALCONBRIDGE

Falconbridge Ltd. operates a nickel/copper smelter and ancilliary facilities in Sudbury and produces sulphuric acid and liquid SO_2 from the sulphur contained in the ore. Falconbridge produced 72,000 tonnes of acid rain-causing SO_2 emissions last year, operating at 69% of its rated production capacity.

Countdown Acid Rain requires Falconbridge to:

- limit its SO_2 emissions to 154 kt effective 1986, and
- reduce the SO_2 emissions from its Sudbury smelter complex to no more than 100 kilotonnes by 1994.

FALCONBRIDGE'S JANUARY 31, 1988 PROGRESS REPORT

SUMMARY	ONTARIO GOVERNMENT RESPONSE
The company appears confident it will meet the 100 kt annual emission level at full operating capacity after 1993. This confidence is based on the positive results from testing of increased pyrrhotite rejection and increased degree of roasting of the ore.	Falconbridge's report met the reporting requirements of O. Reg. 661/85 as well as addressing previous suggestions of the Ministry of the Environment. Details on capital and operating costs will be provided in upcomihng reports. A breakdown of the sulphur reductions to be achieved in each area was not provided.

A. Pyrrhotite Rejection

Various programs are underway to achieve more streamlined and uniform concentrate production with increased pyrrhotite rejection in mineral benefication operations. The immediate objective is to minimize the loss of nickel-bearing pentlandite associated with pyrrhotite rejection.

B. Smelter

Operating the electric furnace at a higher matte temperature has created structural instability in the furnace wall which has been overcome by installing customized cooling devices.

Falconbridge is working with Ontario Hydro to develop and test a new electric furnace. The handling of extra furnace gas due to the extra reductant is a problem.	
SO_2 converter slag cleaning has reached prototype/commercial operation. Finetuning is underway to make it cost effective. Other reducing agents are being investigated.	This will help meet SO_2 limits by reducing converter slag recycle load to the furnace as well as lowering the metal losses in the slag.

C. Acid Plant

The roasting plant is still short 10% to 15% in gas handling and cleaning capacity; hence some changes in gas cleaning for trace metal/impurities removal and SO_2 conversion to SO_3 (without sacrificing efficiency) are being examined.	If this work is not successful the company may need to build a third roaster and expand the acid plant capacity.

ALGOMA STEEL (WAWA)

The Algoma Steel Corporation Ltd. operates an iron sintering plant in Wawa (270 km northwest of Sault Ste Marie). Countdown Acid Rain limits the SO_2 emissions from the operation to 180 kilotonnes per year in 1986 through 1993, and to 125 kt in 1994 and thereafter. The previously existing limit was 285 kt.

As of August 1, 1986, Algoma Ore Division decreased its production capacity at Wawa from 2.0 million tons per year to 0.9 million tons per year which results in an SO_2 emissions level of 85,000 tonnes.

ALGOMA STEEL (WAWA) JANUARY 31, 1988 PROGRESS REPORT

SUMMARY	ONTARIO GOVERNMENT RESPONSE
The fourth progress report said there had been no change to the economic conditions facing the steel industry so the company would continue its Wawa operations at reduced capacity. The company also noted that it would obtain ore from sources other than Wawa should market conditions change.	The technical committee found that the reporting requirements of Regulation 663/85 have been met with respect to the January '88 progress report. Again as indicated in reviewing the second progress report: • If economic conditions change and the company wishes to increase its production at Wawa again, utilizing any ore containing sulphur, acid gas reduction methods or procedures such as those previously examined would have to be in place before production could significantly increase. The company appears to be able to submit the "Final Written Report" required by Section 4 of the regulation without further delay.

ONTARIO HYDRO

Ontario Hydro operates coal-burning electrical power generating stations at five locations in Ontario; three major plants in southern Ontario, and two smaller plants in the north-west part of the province. Two oil-fired units near Kingston were re-activated in December 1987 to provide system peaking capacity. Overall, Ontario Hydro produced 332,000 tonnes of SO_2 last year.

Countdown Acid Rain prescribes a schedule of reductions in the SO_2 legal limits, from 370 kilotonnes in 1986, to 240 kt in 1990, to 175 kt by 1994. There are also corresponding limits on the sum of SO_2 plus oxides of nitrogen (NOx). These limits apply regardless of anticipated future increases in demand for electricity.

In May 1987, the Government removed an emission banking provision. No change was made to the actual emission limits.

ONTARIO HYDRO'S JANUARY 31, 1988 PROGRESS REPORT

SUMMARY	ONTARIO GOVERNMENT RESPONSE
Ontario Hydro has formally submitted its program Environmental Assessment (EA) for the retro-fit of flue gas desulphurization equipment on selected coal-fired generating units. The official government review of the EA currently being developed is based on comments from government ministries, public agencies and commissions. The period for public review of the EA and the government's review will begin in the next several months.	Hydro's fourth progress report has satisfied the formal requirements of the regulation (O. Reg. 281/87). It was noted that acid gas emissions were kept below the legal limit, while demand for electrical power required a 37% increase in the electricity produced from coal-fired generation. Activity has continued with respect to Environmental Assessment procedures, to ensure that Hydro is in a position to retro-fit scrubbers. In future reports, it would be helpful if Hydro were to provide greater context for the direct abatement actions which are underway, by discussing other options more fully. These could include electricity conservation measures, parallel generation including co-generation, purchases or development of indigenous hydro-electric power, increased use of low sulphur coal or new clean coal technologies, and potential for natural gas as a replacement fuel for coal. Up-dated information on actual and projected demand growth would also be helpful.

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